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CORN RAISING IN MINNESOTA

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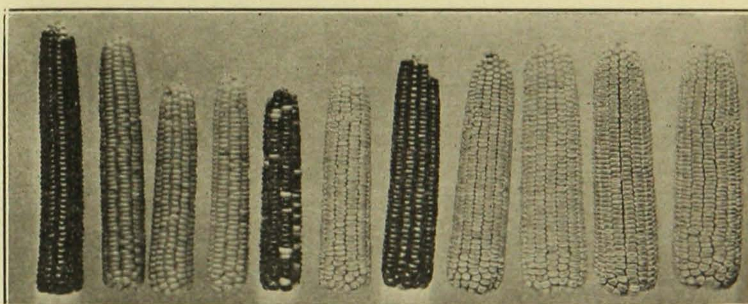

1 2 3 4 5 6 7 8 9 10 11

Fig. 1. Recommended Varieties for Minnesota

Southern section: (10) Murdock, (11) Silver King, and for the less productive soils (8) Minnesota No. 13 and (9) Rustler.

Central section: (8) Minnesota No. 13 and (9) Rustler.

Northwestern section: (6) Minnesota No. 23, (7) Northwestern Dent, early strains of Minnesota No. 13, and flint varieties such as (1) King Phillip and (2) Longfellow.

Northeastern section: Earliest flint varieties as (3) Gehu, (4) Dakota White, and (5) Squaw.

During the ten-year period from 1911 to 1920, inclusive, there was a gain of more than a million in the average number of acres of corn grown annually in Minnesota and an average increase of 5.4 bushels in the yield per acre as compared with the acreage and yield per acre from 1901 to 1910, inclusive. This was an increase of approximately one-third in the acreage and one-sixth in the yield per acre during the last ten-year period. In 1921 Minnesota ranked eighteenth among the states in acreage devoted to corn, and in 1920, fourteenth.

From 1901 to 1910 the corn crop of the state was exceeded in average value by the wheat and oat crops with barley fourth in value. On the average, during the period 1911 to 1920 the value of the corn crop for the state was very close to the value of the wheat crop and nearly equal to the combined values of the oat and barley crops.

Table I. Comparative Production and Value of Corn in Eight States, 10-Year Average; 1911-1920, Inclusive

State	Acreage	Bushels per acre	Farm price per bushel	Value per acre
Iowa	10,125,000	37.3	72.9	$27.27
Illinois	10,056,000	33.9	77.7	26.51
Nebraska	7,502,800	24.5	74.6	17.84
Indiana	5,017,500	36.4	77.7	27.95
Ohio	3,822,300	39.1	82.8	31.30
Minnesota	3,683,200	34.7	73.0	25.57
South Dakota	3,003,500	28.2	71.3	19.44
Wisconsin	1,765,600	36.3	89.1	31.74

The ten-year average yield of 34.7 bushels per acre is 2.6 bushels less than that of Iowa and 0.8 bushel more than that of Illinois. A large number of growers in this and other corn states, however, are producing, regularly, yields varying from 50 to 75 bushels per acre, or about twice the average yield for the state, hence many must be producing less than the ten-year average yield per acre.

ESSENTIALS FOR HIGHER YIELDS

On the average Minnesota farm the yield of corn can be increased from 30 bushels per acre or less to 50 bushels or more at a very small additional cost. It is largely a matter of looking ahead to get the soil in the best condition; to get the right seed; and to see that all the work in connection with the crop is done well, at the proper time, and at the lowest cost.

With favorable weather conditions the essentials for securing yields of from 50 to 100 bushels of corn per acre are: (1) an adapted high-yielding variety; (2) good seed; (3) a highly productive soil; (4) a well-prepared seedbed; (5) a good stand; (6) proper cultivation. Unsatisfactory yields of corn are largely due to the neglect of one or more of these essentials.

AN ADAPTED HIGH-YIELDING VARIETY

The choice of the variety to plant in any particular section of the state merits careful consideration. Only varieties that will mature each year before killing frosts should be considered. Thoroly mature corn has germs of good size and a large proportion of flinty material in the kernel. Differences in the germs and the surrounding parts of mature and immature kernels are shown in Figure 2.

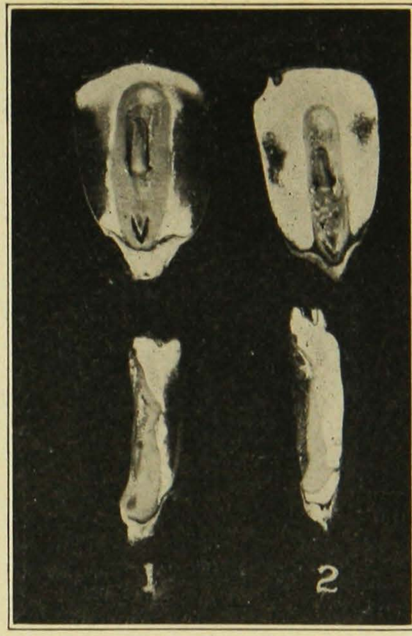

Fig. 2. Mature and Immature Corn

1. Above in the large germ can be seen the root and stem of the young corn plant surrounded by the dark flinty material. Below, a mature kernel cut in two lengthwise shows the germ at the left and the flinty material at the right.
2. Note the shrunken germ and starchy surrounding part.

In order to secure good yields of corn per acre large ears are not necessary. An average of 3 eight-ounce ears or four six-ounce ears per hill checked 3 feet 6 inches will amount to 75 bushels per acre.

The varieties listed in the following table have been found by trial to be relatively high yielders and are recommended for the sections of the state to which they are known to be adapted.

The ears and kernels and in some cases the plants of these varieties have a characteristic appearance by which each may be easily recognized.

Besides these widely grown and easily recognized varieties there are local varieties and strains grown in the state, some of which are distinct in appearance. In all probability there are high yielding varieties among them. The only way to ascertain the value of these local varieties is to make a comparative yield test using one of the recommended varieties as a check. If the local variety or strain yields no better than the recommended one used as a check, it can well be discarded in favor of the latter since there are decided advantages in growing a widely used and easily recognized variety.

Table II. Recommended Varieties for Minnesota

Variety	Approximate days to mature	Approximate size of ears		Aver. No. of rows	Color		Character of dent
		Length	Circumference		Grain	Cob	
Southern Section:							
Silver King......	120-125	8-9.5	6.5-7	16	Creamy white	White	Wrinkled to dimpled
Murdock	120-125	8-9.5	6.5-7	16	Yellow	Red	Wrinkled to dimpled
Rustler	110-120	8-9	6.5-7	16	White	White	Dimpled to wrinkled
Minn. No. 13.....	110-120	8-9	6.5-7	16	Old gold	Red	Dimpled to wrinkled
Central Section:							
Minn. No. 13.....	110-120	8	6.5-7	16	Old gold	Red	Dimpled to wrinkled
Rustler	110-120	8	6.5-7	16	White	White	Dimpled to wrinkled
Northern Section:							
Minn. No. 23.....	90-100	6.5-7	5	12	White cap yellow	Pink	Dimpled
Northwestern Dent	100	8	6-6.5	12	Yellow cap red	White	Dimpled
Minn. No. 13 (early strains)..	100-110	7-8	6.5	16	Old gold	Red	Dimpled
Various Flint corns	90-100	6.14	4.5	8-12	Various	Various	

Varieties for Silage

In most cases the same variety grown for grain production will prove satisfactory for silage also. However, since it is not necessary that corn for good silage mature beyond the beginning dent stage before cutting, some growers, particularly those in the northern part of the state, can use to advantage a somewhat larger corn for this purpose. Choice for this purpose should be limited to varieties which will produce ears that reach the beginning dent stage before killing frosts.

New Varieties

New varieties of corn worthy of trial will continue to be developed in the future. Any promising varieties that come out will be given careful trials at the Central experiment station and the substations in comparison with recommended varieties and if found superior will be given a place on the recommended list. Corngrowers will do well to inquire at University Farm or the substations regarding new varieties before purchasing seed.

GOOD SEED

There are several considerations with regard to the seed corn itself in addition to that of variety which are exceedingly important. If the seed is purchased, as it will need to be in starting with a different variety from that now grown, where shall it be purchased? In selecting seed corn from the fields on the farm, when and how shall the selection be made? After the corn is selected how shall it be dried, stored, and prepared for planting?

Home Grown Seed Best

After securing a start with a suitable variety, it is to the advantage of individual growers to select sufficient home-grown seed corn each year for their own needs, employing the best known methods in doing this work.

However, when seed corn must be purchased, it should be secured from growers preferably in the same latitude or within from fifty to one hundred miles north or south. Seed brought in from too far north is likely to produce plants too early in maturity to make full use of the growing season and hence low yields will result. Seed corn grown too far south, on the other hand, will produce plants too late in maturity and in the average season the corn is likely to be immature.

Time to Select Seed Corn

For several reasons it is very important that seed corn be selected in the field as the plants are maturing. The best time is when the leaves of the plants are still green, the husks beginning to turn yellow, and the ears well dented. When the seed ears are selected from the plants as they are maturing, the choice can be made on a sound basis to maintain or increase the yielding power of the variety and diseased plants can be recognized and avoided. At the same time, the corn is gathered early enough so it can be cured without danger of injury by freezing. To put off the selection until the leaves on the majority of the plants are yellow from natural ripening or from killing by frost makes efficient selection difficult.

Corn Necessarily Cross-fertilized

It is necessary that corn be cross-fertilized in order to maintain vigor and yielding power. All the well-established varieties of corn are made up of a number of strains of which the plants, ears, and kernels may be very similar in appearance to the casual observer. Closer inspection, however, reveals differences in type and vigor of plants and in ear and kernel characteristics. Only as crossing takes place between strong plants of these different strains can the fullest measure of vigor and yielding ability be maintained within a variety.

The Plant the Basis of Selection

In order to eliminate weak strains as they occur within a variety so that a high percentage of the plants in succeeding crops may be strong and vigorous, it is necessary each year to select seed ears from normal vigorous plants in full-stand hills. To be most effective, this selection must be made when the leaves on the majority of the plants are still green, the husks beginning to dry and turn yellow, and the ears well dented. Diseased plants mature earlier or considerably later than normal healthy plants as a rule, and frequently they break over. Again, shanks on apparently strong plants may be so diseased that the ears hang straight down instead of being held in proper position. When the selection is made at the proper time from the standing plants, these diseased plants can usually be recognized and avoided.

Inherently weak plants growing in full-stand hills are at a decided disadvantage in competition with their stronger companions, and their undesirability as seed stocks is easily recognized. However, if inherently weak plants grow alone or in hills with less than a normal stand of three or four plants they may have a strong appearance and develop reasonably good ears. When the selection is made in the field on the basis of the plants, hills with a stand less than normal should always be avoided entirely. On the other hand, when seed ears are selected from the husked corn, there is no way of knowing what kind of plants produced them or what the stand was in the hills. Therefore, effective selection of seed ears from husked corn is impossible.

Amount of Seed to Select

Fifty-six pounds of shelled and graded seed corn is sufficient to plant 7 or 8 acres when checked 3 feet 6 inches apart and 3 or 4 kernels per hill. One and a quarter to one and a half bushels of ears selected at the proper time from strong plants usually provides ample seed corn for planting 7 or 8 acres and still allows considerable latitude for discarding undesirable ears and ears that are diseased or low in germination.

B A

Fig. 3. Healthy and Diseased Corn Plants.

A, Healthy, with leaves and stalk green and ear ripe and in normal position.

B, Diseased, with leaves and stalk dead and ear prematurely ripe hanging from a rotted, broken ear shank.

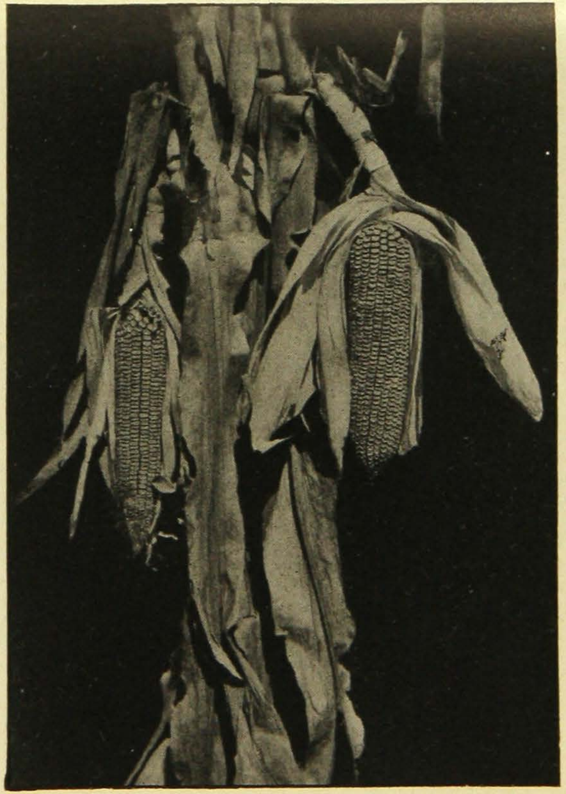

Fig. 4. Two Ears of Corn on Rotted, Broken Ear Shanks. One ear looks good enough for seed, but it really is badly diseased.

Curing and Storing Seed Corn

As soon as seed corn has been selected in the field, it should be placed under shelter where there is a free circulation of air about each ear. Free circulation about each ear reduces the moisture content rapidly and lessens the danger of damage by rots, molds, and freezing. After the seed ears have been well cured they may be stored with safety in much less space, provided the moisture content is not allowed to increase to any extent.

Final Selection of Seed Ears

All ears that are decidedly unlike the general run for the variety should be eliminated. Close selection to any particular type, if followed from year to year, is likely to result in lower yields. This undesired lowering in yielding power is brought about by eliminating through close selection some of the desirable strains which recombine each year through cross-fertilization to maintain vigor within a variety.

All ears that are obviously immature, starchy, very rough, dull in appearance, or discolored, or affected by molds at any point of the ear or cob should be discarded before the germination test is made.

The Germination Test

Selecting seed ears from strong plants and caring for them in the manner outlined should result in corn of relatively high and strong germinating power and reasonable freedom from disease. However, to make certain that the germinating power is satisfactory, a preliminary test of kernels from ears located in different parts of the storage quarters is always advisable before shelling. If the preliminary test indicates that the germinating power is doubtful or that considerable rot and mold are present on the seedlings, an individual ear test is necessary.

Whether an individual ear test should be made especially to detect and discard diseased ears, depends on the indications of the presence of disease. Some idea of the extent to which disease is present in individual fields may be obtained by observing the plants closely throughout the growing season. The chief indications of disease are: (1) marked thinning of stands by plants dying in the seedling stage; (2) very uneven development of the plants between the seedling and tasseling stages; (3) the presence of a considerable number of prematurely ripened plants some of which break over at the ground or farther up while the majority of the plants in the field are still green; (4) the presence of plants that mature long after the majority of the plants have reached maturity; (5) diseased shanks which permit the ears to hang straight down; (6) very rough ears with starchy kernels; (7) all or a portion of kernels discolored or moldy; (8) the cobs at the butts of the ears frayed or colored brown or pink.

When the presence of considerable disease is noted from the appearance of the plants in the field, the individual ear test will disclose diseased ears which might otherwise be used for seed.

The Modified Rag Doll Germinator

The use of the modified rag doll germinator, as described fully in Farmers' Bulletin No. 1176[1], is a simple and efficient method of testing individual ears for germinating power and disease infection at the same time.

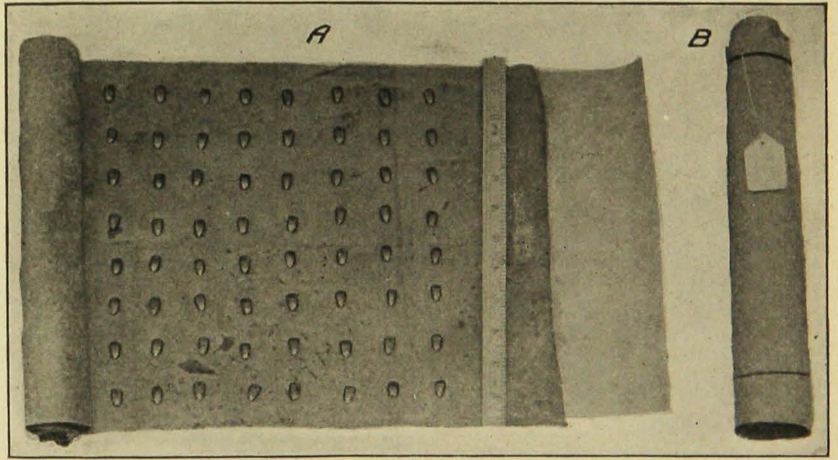

Fig. 5. Improved Rag Roll Germinator
A, Open, showing insulating paper, cloth, and corn kernels in position; B, rolled and labeled

To make a modified rag doll, cut strips of muslin 12 inches wide and 54 inches long and boil thoroly in order to sterilize them. Then lay this cloth on a strip of very heavy hard-finished paper the same width and 6 inches longer. The purpose of the heavy glazed paper is to keep the molds that may develop on the kernels from one ear from growing through the cloth and affecting kernels from the other ears when the rag doll is rolled up. When the ears to be tested have been laid in order or numbered, from 8 to 10 kernels are taken from each ear and laid in straight rows, germ side down and tips pointing toward the operator. The kernels from 20 ears

[1] Holbert, James R. and Hoffer, George N. "Control of the root, stalk, and ear rot diseases of corn." 1920.

are placed on the one rag doll as shown in Figure 5. The cloth is then thoroly wet and all is rolled rather tight, and a label is attached to the upper end giving the date and the numbers of the ears from which the kernels were taken.

The rag dolls as they are made up are put in a box with double sides 3 or 4 inches deeper than the height of the dolls and of a size suited to the amount of corn to be tested. The inside box is 6 inches shorter and narrower than the outside box. It is from 3 to 4 inches less in depth than the outside box and has no bottom. At the bottom of the outside box is placed 3 or 4 inches of clean

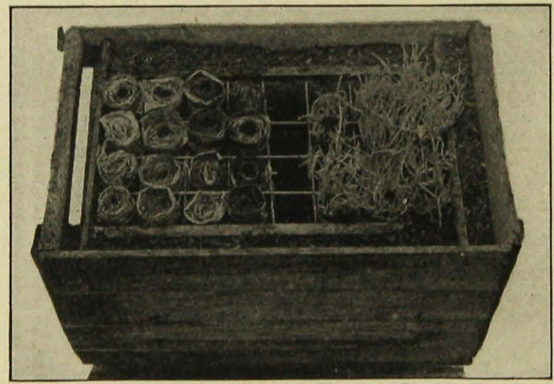

Fig. 6. Modified Rag Doll Seed Germinators, Showing Double Box with Rag Dolls in Position

sawdust; the inner box is then put in place and the space between the two is filled with wet sawdust. When ready to use, the sawdust is made thoroly wet with hot water which drains through. The box should stand in a warm room. The temperature in the box is maintained at from 75 to 85 degrees F. by pouring twice daily about two pails of hot water over the sawdust at the sides. At the same time the dolls should be sprinkled with warm water. The box should be placed on tarred paper or roofing arranged so that the water will drain into receptacles. An electric bulb may be used to maintain the desired temperature if this is more convenient than using the hot water. If electricity is used for heating, the sawdust must be kept moist by adding hot water as needed.

Reading the Test

The test may be read when the stems show 2 or 3 inches above the upper ends of the rag dolls and the roots project below. This requires from 7 to 10 days. A rag doll partly unrolled for reading is shown in Figure 7.

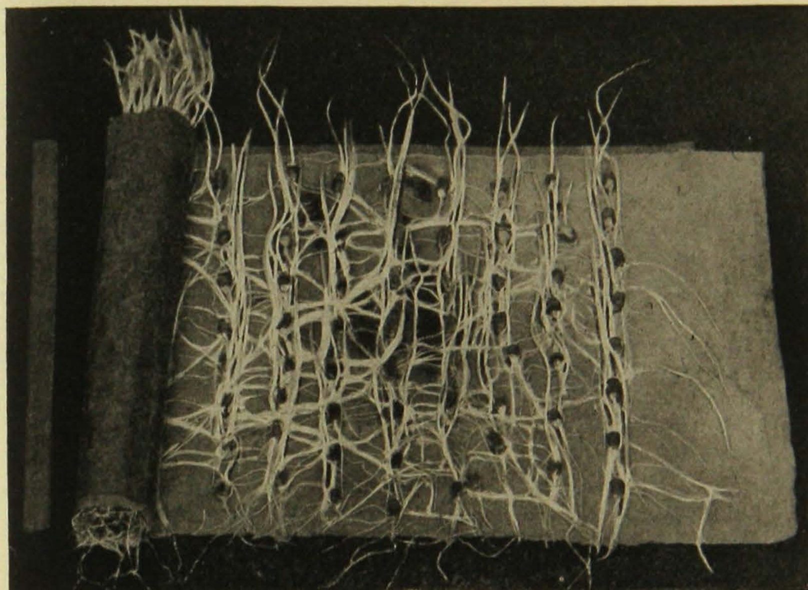

Fig. 7. Rag Doll Germinator Unrolled for Reading of Results

Ears of corn selected for seed may be unfit for this purpose owing to injury of the kernels by frost, improper curing, or faulty storage. Kernels that have been injured in this way show either no germination or slow and weak growth of the seedlings. When the kernels in the germinator show this kind of injury, the ears from which they came should be discarded. Ordinarily, weak or slow germination of the kernels should bring about the discard of ears just as quickly as entire failure to grow.

The presence of diseases on seedlings is the other type of injury which makes the ears from which they came unfit for seed. Brown rot affecting the stems or the roots of the seedlings, near the kernels particularly, and pink discolorations indicate the presence of harmful disease and the undesirability of the ears from which they came for seed purposes. One row of badly diseased seedlings is shown at the bottom in Figure 8.

Note the thin and rotted stems and roots appearing dark-colored. In the center is a row of weak and diseased seedlings. At the top is a row of seedlings from uninjured and disease-free kernels. The vigor of the stems, the large number and the thickness of the roots, the presence of an abundance of rootlets, and a glistening white color throughout leaves no doubt as to the desirability of the ear from which they came for seed purposes.

After the cloths for rag dolls have been used once they must be boiled thoroly before they are used again. New papers must always be used.

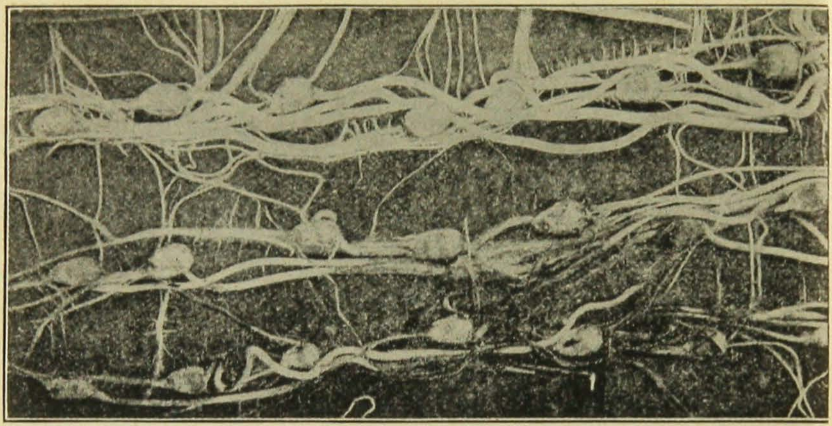

Fig. 8. Corn Seedlings from Two Diseased Ears (below) Contrasted with Seedlings from a Disease-Free Ear (above)

Note the dark areas on the diseased seedlings, showing where the mold is rotting them. The kernels from each ear are laid in a single row in a horizontal position, which tends to prevent the lateral spreading of the molds to adjacent rows.

Shelling and Grading

If seed corn is shelled by hand, each ear in a separate container, the kernels may be examined before they are mixed with the others. Individual ears may be discarded if, on this last examination, they are found to be starchy or otherwise undesirable. Where corn is to be shelled on a large scale the use of the sheller is necessary. After the shelling is completed, the corn should be put through a good grader which will separate it into uniform lots to which the planter can be satisfactorily set.

Keep a Reserve Supply

High-quality seed corn may be stored for a year either on the ear or shelled, in dry, well ventilated, vermin-free quarters without any lowering in the percentage or strength of germination. Sacks of shelled corn should not be allowed to remain over summer on a concrete floor in an ordinary storage room. The use of one-year-old seed and the holding over of that gathered and prepared from the current crop obviates the necessity of using relatively undesirable seed produced in an occasionally unfavorable year.

HIGHLY PRODUCTIVE SOIL

Corn requires for its best development well-drained, deep, mellow soil that holds moisture and contains a generous supply of plant food. Nature has given all these desirable qualities to few fields.

In modifying soils so that they become more suitable for corn production, the importance of organic matter can scarcely be overemphasized. Organic material may be added to the soil in the form of legume or grass plants used as green manure or the crops may be removed and only the stubble and roots plowed in as crop residues. Organic material may also be added to the soil in the form of barnyard manure.

Organic Matter Improves Physical Condition of Soil

The beneficial effect of organic material on the physical condition of the soil is very marked. Without a plentiful supply soils become compacted and lack an adequate supply of air, rain is not readily absorbed, and the water-holding capacity is somewhat lowered. Tillage implements leave the soil in clods which bake easily. When in this condition, soils can hardly produce well even tho the various plant foods are present in sufficient amounts. On the other hand, if generously supplied with organic matter, ordinary soils become mellow and well aerated. They absorb water readily, store it in somewhat larger amounts than when the supply of organic matter is low, and can be cultivated more easily, earlier in the spring, and sooner after the rains.

Organic Matter Aids in Liberation of Plant Food

The materials which plants take from the soil dissolved in water are usually not soluble in large amounts at any one time, but under proper conditions become available gradually. Ordinary soils, when well supplied with organic material, become the home of large numbers of bacteria and other lower forms of living organisms which live on the organic matter and in working it over bring about important changes resulting in the liberation of materials which are soluble in water and can be used as food by plants.

Essential Plant Foods Need Consideration

There are a number of materials which plants take from the soil in small amounts dissolved in water. Among these are nitrogen, phosphates, potash, and lime. The supply of these may not be sufficient to meet the needs of plants.

Potash usually abundant.—In the mineral soils of Minnesota, potash is usually available in sufficient amounts for the use of corn plants. Therefore, until the present supply runs low no provision need be made for an additional supply. Barnyard manure and other organic matter applied to soils supply potash in small amounts.

Phosphates need consideration.—Soils from which crops and livestock have been sold for several years and only small amounts of feeds have been purchased, fed, and the manure returned to the land, need checking up as to the supply of phosphates available to crops. The application of phosphates in commercial forms have given profitable returns in West Central Minnesota.[2] Whether or not the application of phosphates will give increased yields of corn on individual farms can be learned only by actual trial. If after trial on a part of a field, phosphates are found to give increased yields sufficient to pay for the cost of the fertilizer and the labor of applying it with a margin of profit besides, then its use on larger fields is warranted.

Lime may aid indirectly.—Corn yields are usually not increased directly by application of lime. However, lime may have a very beneficial effect on the leguminous crop which precedes corn, and in this way aid very materially in an indirect way. Whether lime is necessary for the leguminous crop can be ascertained by trial.

Nitrogen must be available.—The supply of nitrogen in the soil is very limited. As it becomes available, it is taken up by plants washed away by water, or lost in other ways, consequently, in order to keep the soil productive, the supply of nitrogen must be renewed regularly. Nitrogen in commercial forms is too expensive to use for this purpose, at least in the production of ordinary farm crops. Fortunately, however, there are ways of maintaining the supply of nitrogen in the soil at a very small expense and at the same time benefiting the soil in other respects as well.

Unleached barnyard manure contains nitrogen, phosphates, and potash. It is a by-product in the raising of livestock and the only expense in its use is the labor of applying it. On most farms, however the supply of barnyard manure is not large enough to furnish the amount of nitrogen needed for profitable crop production. The deficiency may be made up by growing leguminous crops, such as clovers, alfalfa, and soybeans. Leguminous crops use the plant foods in the soil as do other crops, but they possess a power not belonging to other plants, that of drawing on the unlimited supply of nitrogen in the air. By growing well-inoculated leguminous crops, therefore, feeding the hay to livestock and returning the manure to the soil, or by plowing under green crops when necessary, the supply of nitrogen in the soil may be not only maintained, but actually increased.

[2] McMiller, P. R., Miller, P. E., and Nesom, G. H. "Phosphate demonstrations in Stevens County, 1918." Minn. Agr. Ext. Special Bul. 34. 1919.

It should be remembered, however, that when leguminous crops are cut for hay and sold there is usually no increase in the nitrogen supply in the soil from which these crops were harvested.

A Good Plan of Cropping Aids

Adopting a good plan of cropping suited to the needs of the individual farm aids in maintaining in the soil the necessary supplies of organic material and nitrogen.

Table III. Effect of Barnyard Manure and Leguminous Crops on Corn Yields at University Farm, 1909-1919, Inclusive

Length of rotation	Crops included in the rotation	Means of supplying organic matter and nitrogen	Yields of corn per acre
			Bu.
Five years	1. Grain 2. Clover hay 3. Pasture 4. Corn 5. Grain	1. Growing clover 2. Pasturing hay crops 3. Applying 10 tons of manure per acre preceding corn once in five years	52.2
Four years	1. Grain 2. Clover 3. Corn 4. Corn	1. Growing clover 2. Applying 8 tons of manure per acre preceding corn once in four years	51.5
Three years	1. Grain 2. Clover 3. Corn	1. Growing clover 2. Applying 6 tons of manure per acre preceding corn once in three years	51.6
No rotation	Corn continuous	Applying 6 tons of manure per acre once each three years	40.1

Manure was applied in the five-year rotation at the rate of 10 tons per acre once in five years; in the four-year rotation at the rate of 8 tons per acre once in four years; and in the three-year rotation and continuous cropping at the rate of 6 tons per acre once in three years. The rate of manuring was the same for the four cropping systems but in the five-, four-, and three-year rotations clover preceded the corn crop. The yields of corn were practically identical in the three rotation systems and 11.5 bushels higher than where no rotation was practiced. The increase of 11.5 bushels per acre was due very largely to the beneficial effect of the leguminous crops preceding the corn in the rotation.

Rotating crops also aids in keeping weeds, diseases, and insect pests in check.

A WELL-PREPARED SEEDBED

Corn usually yields equally well on fall- or early spring-plowed fields. Except on very uneven fields where serious washing of the plowed land is likely to occur, fall plowing in preparation of the seedbed for corn is usually good practice for the following reasons: (1) There is usually more time for plowing in the fall: (2) the loosened soil absorbs moisture more readily; (3) weeds and cutworms are more easily controlled: (4) the sods in meadows or pastures and any barnyard manure that may be plowed under have time to decay so that good connection is established between the soil in the furrow slice and that beneath. When sods or manure are plowed under late in spring, the ground prepared in the usual manner, and the corn planted soon after, the young plants may not be able to secure enough water for their needs unless timely rains fall. This is because the roots of the young corn plants can not pass readily through the large air spaces in the unpacked soil to get down below the furrow slice where the supply of moisture is abundant.

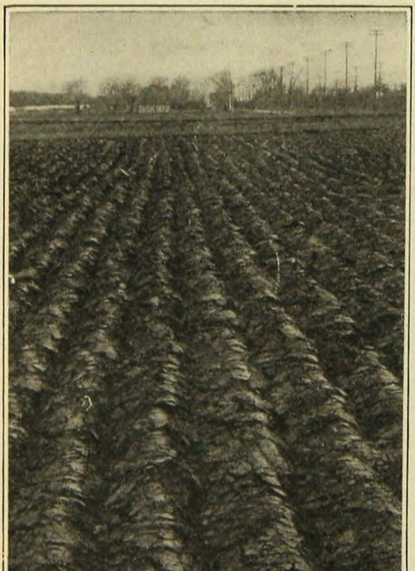

Fig. 9. Well-Plowed Soil

Deep Plowing Desirable

Fall and early spring plowing for corn should be as deep as is practicable. Generally the heavier the soil the deeper it should be plowed. When the soil is plowed 4 or 5 inches deep and the cultivator run to a depth of 2 or 3 inches, only from 2 to 3 inches of loosened soil is left undisturbed in which the roots of young plants may spread out easily. Plowing from 6 to 8 inches deep almost doubles this loosened area. The depth of plowing should be increased gradually, so that no large amount of raw soil is brought to the surface in any one year.

Early Spring Disking Important

In the spring, as soon as the small grains are planted, fields plowed for corn in the fall should be thoroly disked. This early disking keeps the moisture in the ground and hastens the warming up of the soil which in turn causes the weed seeds to germinate and grow. Subsequent harrowings or diskings as needed to keep the weeds from showing green above ground furthers the cleaning process. Cutworms can not live in fields where all green plants have been destroyed.

Treating fields in this way provides well pulverized clean seedbeds ready for planting as soon as all conditions are favorable. It is much more economical to cultivate corn fields thoroly before the seed is planted than afterwards.

Eliminate Gophers

While preparing the soil, all the striped and gray gophers in the vicinity should be poisoned. Dissolve one-eighth ounce of strychnine in a gallon of hot water and allow it to cool. Then add as much corn as the solution will cover. In from eighteen to twenty-four hours the corn will have absorbed sufficient poison to be effective. If any of the solution is left, more corn may be put in. This corn may be put in gopher holes in the field and along its borders. In pastures it is always necessary to put the corn far enough down in the holes to be beyond the reach of domestic animals.

A GOOD STAND

The work expended in making a proper selection of seed, preparing the seed for planting, and getting the soil in good condition is partly lost unless good stands of plants are secured. Therefore every effort should be made both before and after planting to secure and maintain as nearly the desired stand as possible. To secure, on the average, three plants per hill, it is necessary to plant four kernels in many of the hills. On the other hand, planting too thickly tends to reduce the amount of grain and increase the amount of stover produced. Proper grading of the seed and adjustment of the planter aid materially in securing even stands of plants. If a very poor stand is secured, it is usually advisable to disk the field and replant it rather than attempt to fill in the missing hills.

Early Planting Best

It is highly desirable to plant corn as soon as the soil is warm and the weather favorable in order to give the plants the longest possible growing season. If disking is started early in the spring and continued at frequent intervals, a mellow warm seedbed, free from weeds, will be ready at any time that the weather is favorable. The usual time for planting in the southern part of the state is from May 1 to 10; in the central part, from May 10 to 20; and in the northern part, from May 20 to June 1 or later; but corn should not be planted at the times mentioned unless the seedbed is warm and the weather favorable for growth.

Thickness of planting

Highly productive soils are able to supply the necessary food materials to a greater number of plants than those low in productivity. Other conditions being about equal, dwarf varieties may be planted somewhat more thickly than tall varieties. For grain-production, checking corn 3 feet 6 inches or 3 feet 8 inches with 3 or 4 kernels per hill is the method usually followed in Minnesota. Checking the corn allows cultivation both ways and gives a better opportunity to keep it free from weeds than drilling. When the soil is exceptionally free from weeds, the corn may be drilled to advantage, and the plants should be from 12 to 14 inches apart in the row.

For silage or for bundle-corn to be fed without husking, an average of a plant every 6 or 8 inches in the row, either checked or drilled, will produce a larger yield and better quality than the thinner planting.

No Advantage in Deep Planting

The depth of planting depends on the condition of the seedbed. From one to two inches is a good depth if the soil is moist. If moisture does not occur within three inches of the surface the corn must be planted that depth in order to secure the conditions necessary for prompt germination. When the season is late and the soil still somewhat wet and cold, planting not more than an inch or an inch and a half deep is best. With conditions favorable for planting corn from one to two inches deep nothing will be gained by planting deeper. The corn plants can not be made to root lower in the soil simply by deep planting; the permanent roots are developed at about the same depth whether the corn is planted two inches deep or more.

CULTIVATION

The purposes of cultivation are (1) to kill weeds, (2) to maintain a condition of the soil favorable to the rapid growth of the young plants, and (3) to form a dust mulch to keep the moisture in the ground. The amount and kind of cultivation necessary for best results depend on the character and condition of the soil at planting time and during the growing season.

Early Cultivation

With the seedbed so thoroly prepared that it is firm below, mellow at the surface, and free from weeds, shallow, early cultivation is all that is necessary. This kills the weeds as they start and prevents the formation of a crust. This shallow early cultivation may be given with a narrow-shoveled cultivator or a light harrow the teeth of which are adjusted to slant backwards. If there are small, loose sods or other material that may be dragged over the rows and prevent the young corn plants from reaching the surface, the cultivator is preferable to the harrow. Harrowing corn after it is up always reduces the stand somewhat. Where there is more than a full stand in the first place the first cultivation may be done in this way at a saving in cost of labor. The harrowing should be done on a bright afternoon when the plants are somewhat wilted and for that reason less easily broken.

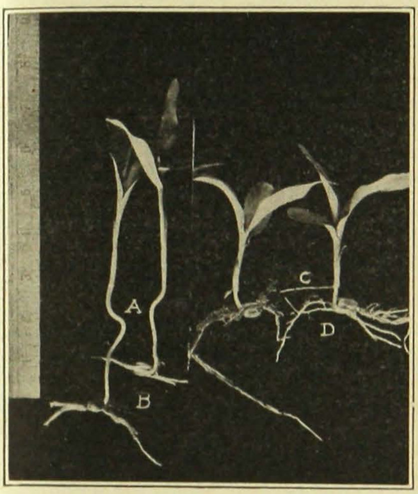

Fig. 10. Young Corn Plants

The kernels of corn producing the two plants on the left were planted $3\frac{1}{2}$ inches deep. Those producing the plants on the right were planted $1\frac{1}{2}$ inches deep. At B are shown the temporary roots which, on account of deep planting, are not so well developed as D from seeds planted less deeply. At C are shown the permanent roots starting $\frac{3}{4}$ of an inch below ground. At A are shown the slight enlargements at which places the permanent roots will develop. They will be the same distance below the ground as those on the plants on the right. The plants on the left were longer reaching the surface and are consequently more spindling.

If the seedbed has not been thoroly prepared, or if heavy rains have packed a well-prepared seedbed after the corn has been planted, the first cultivation should remedy this condition as far as possible. Medium deep cultivation, either before the corn is up, or as soon as the rows can be seen is advisable in such cases. This should be followed by a deep and close cultivation each way by the time the corn is from 4 to 6 inches high. Preparation of the seedbed after the corn is planted is less effective and costs more than when done at the proper time.

Late Cultivation

Late cultivations are mainly for the purpose of killing weeds and retaining moisture. Shallow cultivation will accomplish both.

As the corn develops, its roots spread outward and downward. The roots that spread outward start near the surface and usually grow somewhat deeper toward the middle of the rows where they cross those of nearby plants. Therefore after the corn is from 6 to 8 inches high, deep or close cultivation becomes increasingly harmful since the roots growing near the surface are cut by the cultivator and the amount of water supplied to the plants is reduced.

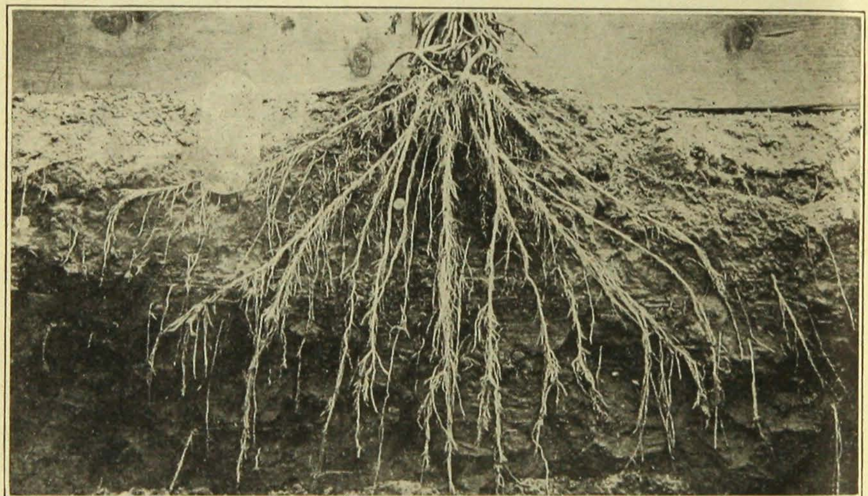

Fig. 11. Roots of Corn Plant. (Courtesy of C. P. Hartley, U. S. Dept of Agriculture.) After corn is six or eight inches tall, close and deep cultivation becomes increasingly harmful.

When corn plants are seen to wilt in the hot sun soon after cultivation, it is a sign that the cultivator is being run too deep.

The frequency of cultivation depends largely on the character of the soil, the condition of the seedbed at planting time, and weather conditions during the growing season. Cultivations should be given as needed to keep the surface of the soil mellow and free from weeds. Any cultivations beyond this are unnecessary and only increase the cost of production.